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Comparison of patients undergoing tracheostomy with and without fiberoptic bronchoscopy

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Abstract
Aim: Fiberoptic bronchoscopy is increasingly being used during tracheostomy, especially in critically ill patients. In this study, we aimed to compare tracheostomy with and without fıberoptic bronchoscopy in terms of procedure time, blood gas values and complications.
Material and Methods: Sixty patients were randomly divided into two groups with 30 in each. Patients who underwent tracheostomy with fıberoptic bronchoscopy were included in Group 1, and without fıberoptic bronchoscopy in Group 2. Patients' age, weight, body mass index, gender, height values, time of tracheostomy (time from skin incision to successful insertion of the cannula), complications, blood gas parameters, length of stay in the intensive care unit and complications were recorded.
Results: The two groups did not differ statistically in terms of demographic data, body mass index and Glascow coma score, length of stay in the intensive care unit, days of stay in the intensive care unit before percutaneous dilatational tracheostomy, status of the person who performed the procedure, complications, and blood gases values in both groups. Although rates of complications detected in Group 2 were not statistically significant. The increase in post tracheostomy oxygen saturation and PaO2 in Group 2 was statistically significant. The duration of the procedure was longer with bronchoscopy.
Discussion: It was shown that fiberoptic bronchoscopy-assisted tracheostomy increased the duration of the procedure, but the complications were similar. Fiberoptic bronchoscopy-assisted tracheostomy can be used safely and effectively.

Keywords
Bronchoscopy; Intensive Care Unit; Tracheostomy

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Introduction

Patients who need long-term mechanical ventilation due to chronic respiratory failure and who cannot be weaned from mechanical ventilation constitute approximately 10% of patients in intensive care units, and tracheostomy is a common procedure in these patients. [1]. Tracheostomy application increases comfort of the patient by providing a safer and manageable airway, earlier transition to enteral feeding, easier oral care and by decreasing the need for sedation. However, although tracheostomy has a long history, its indications, duration, techniques, cost and utility are still controversial [2]. In addition, tracheostomy has been associated with several complications, including stoma infection, pneumothorax, subcutaneous emphysema, tracheomalacia and tracheal stenosis [3].

Today, one of the most important questions is in which patients, when and through which techniques the tracheostomy will be performed. In a review published in 2018, it has been recommended that it would be beneficial to inspect the position of the tracheal tube and fiberoptic bronchoscopy can be used to avoid injury and stenosis, if necessary [2]. Some researchers have reported that fiberoptic bronchoscopy (FB) reduces the length of stay on mechanical ventilation, shortens the duration of hospital stay and the duration of intensive care, and if initiated early, causes less harm to the upper airways [4, 5]. Tracheostomy performed utilizing FB has been reported to have advantages, such as determining the incision site, avoiding accidental extubation, and detecting and managing complications (6). However, tracheostomy without FB has been proposed as an effective and safe method and to reduce healthcare costs (7).

This study's objective was to compare patients undergoing FB-assisted tracheostomy and those undergoing tracheostomy without FB in terms of the time of the procedure, patients' blood gas changes, and complications.

Material and Methods

This prospective randomized controlled study enrolled a total of 60 patients aged between 20-70 years, who were hospitalized in the reanimation unit of our hospital and underwent tracheostomy under elective conditions due to prolonged need for ventilatory support. The first patient was selected by lot and the other patients were sequentially allocated to the fiber optic group (Group 1) and the non-fiber optic group (Group 2).

Enteral feeding of the patients was terminated 4 to 6 hours before the procedure. All tracheostomy procedures were performed electively at the intensive care beds by 2 inexperienced (at least 5 tracheostomies) under the supervision of the experienced physicians and 2 experienced (at least 50 tracheostomies) reanimation specialists.

Patients with infections at the site of tracheostomy, those with known or suspected intubation difficulties, patients with a history of neck surgery or anatomic disorders, those aged under 18 years old, patients with a PEEP value> 10 mmHg, bleeding diathesis and a platelet count <75000/dL were excluded from the study.

Patients' age, gender, weight, height, BMI values, cause of admission to the intensive care unit, GCS score, time of tracheostomy (time from skin incision to successful insertion of the cannula), complications, blood gas parameters, length of stay in the intensive care unit and complications were recorded. Patients were routinely monitored with continuous ECG, arterial blood pressure, and pulse oximeter. Patients were administered IV fentanyl (2 mcg/Kg), propofol (2 mg/Kg), midazolam (2 mg) and vecuronium (0.1 mg/Kg) before the procedure as anesthetic management. Fifteen minutes before the procedure, oxygen concentration (FiO2) was increased to 100% during the procedure, and the patients were ventilated with Puritan Bennett 840 Ventilator System (Purital-Benneth Corporation, Overland Park, USA) assisted at control volume mode with tidal volume of 6-8 mL /Kg and respiratory rate set to normo-capnia.

Tracheostomy Procedure

Tracheostomies were planned to be opened below the ring under the cricoid cartilage (between the 2nd and 3rd cartilages). The surgical site was cleaned with iodine solution, and covered sterile. In order to reduce bleeding, 2 mL 2% lidocaine with adrenaline (1:80000) was injected subcutaneously to the incision site. A 10-15 mm transverse incision was made from the tracheostomy site. A No. 140 cannulated needle was advanced at the midline through the tracheal rings towards posterior and caudal and the guidewire was left in the tracheal lumen. A lubricated small dilator was then slided over the guidewire to create a hole and the small dilator was withdrawn. The blue rhino dilator was pushed towards the tracheal lumen in the same way to create a hole large enough for the cannula to pass through.

In Group 1, the incision site on the trachea was determined utilizing the light of the bronchoscope with the Ciaglia Blue Rhino method, and the guidewire was confirmed to be within the trachea. In addition, the position of the cannula was also confirmed after the insertion. In Group 2, tracheostomy was opened with the Ciaglia Blue Rhino method without using bronchoscopy. In both groups, the heads of the tracheostomy tubes were inflated with air and both lungs were heard in order to confirm the success of the tracheostomy procedure.

Ethical Consideration

The local ethics committee of our hospital approved the study protocol prior to its initiation. The information about the aim of the study was given to the relatives of the patients, and written consent was obtained from the relatives of the patients who participated in the study. The study was conducted within the ethical principles of the Declaration of Helsinki.

Statistical Analysis

The data of this study were statistically evaluated using the SPSS for Windows (Statistical Package for Social Sciences, version 15.0) package software. Study parameters were evaluated using descriptive statistical methods (frequency, standard deviation, mean and percentage), as well as the Kolmogorov-Smirnov test to analyze the normality of the variables. For comparing the quantitative variables, an independent samples t-test was used for the comparison of parameters, which were normally distributed and the Mann-Whitney U test was used for the comparison of parameters, which were not normally distribution between the groups. For intra-group comparisons, paired samples t-test was used for parameters conforming to the normal distribution, and the Wilcoxon test was used for

the parameters not conforming to normal distribution. For comparison of qualitative data, the Chi-square test was used. The p<0.05 values were considered statistically significant.

Results

This study included a total of 60 patients who underwent tracheostomy with or without FB under elective conditions due to prolonged mechanical ventilation. Patients' average age was 56.6±20.2 (min-max: 20-70) years; 18 (30%) patients were female and 42 (70%) were male. The patients were separated into two groups as Group 1 and Group 2. Each group had 30 patients. There were no statistically significant differences between the groups in terms of gender and age. (p=0.573 and p=0.214, respectively). The demographic data of the groups are shown in Table 1.

The mean GCS was 6.0±2.9 in Group 1 and 6.0±3.1 in Group 2, and the difference was not statistically significant (p=0.999). The number of days on ventilation was 9.1±5.8 days in Group 1 and 7.3±5.9 in Group 2 with no statistically significant difference between them (p=0.081).

Tracheostomy procedure time was notably longer in Group 1 compared to Group 2 (p<0.001). However, no major difference was found between experienced and inexperienced practitioners in terms of the mean procedure time (p=0.739) (Table 2).

Whereas no statistically notable difference was found between Group 1 and Group 2 in terms of SaO2 before and after the procedure (p=0.938 and p=0.760, respectively), the increase in SaO2 after tracheostomy was statistically significant (p=0.009). No statistically significant difference was found between the groups in terms of PaCO2 values before (p=0.283) and after (p=0.321) tracheostomy operations. In addition, there was no significant difference between the groups in themselves before and after the procedures (p>0.05). While no significant difference was found between Group 1 and Group 2 in terms of PaO2 values before and after tracheostomy procedures (p=0.363 and p=0.191, respectively), the increase occurred following tracheostomy in Group 2 was statistically significant (p=0.031). No statistically remarkable difference was found between the groups in terms of H2CO3 values before (p=0.367) and after (p=0.230) tracheostomy operations. In addition, there was no notable difference between the groups in themselves before and after the procedures (p>0.05). Again, no notable difference in pH values both between the groups and within the groups themselves before and after the procedures (for all p>0.05). Comparison of blood gas values before and after tracheostomy operations according to the groups is presented in Table 3.

Table 1. Distribution of demographic features by group

	Group 1		Group 2		p
	Mean	± SD	Mean	± SD	
Age	53.4	21.3	59.9	18.9	*0.214
Height	170.8	11.3	171.4	10.0	*0.847
Weight	74.6	13.3	81.5	14.5	*0.060
Body Mass Index	26.5	5.2	28.3	5.6	*0.202
	n	%	n	%	
Gender					
Male	22	73.3	20	66.7	**0.573
Female	8	26.7	10	33.3	

BMI: Body Mass Index
* Independent samples t test, ** Chi-square test

Table 2. Distribution of tracheostomy times and practitioners according to the groups

	Group 1		Group 2		p
	Mean	± SD	Mean	± SD	
Tracheostomy time (min)	13.4	4.9	8.1	6.1	*< 0.001
	n	%	n	%	
Practitioner					
Experienced	25	83.3	24	80	**0.739
Unexperienced	5	16.7	6	20	

* Mann-Whitney U test, ** Chi-square test

Table 3. Comparison of blood gas values according to the groups

	Group 1		Group 2		p
	Mean	± SD	Mean	± SD	
SaO2					
Before PDT	97.1	3.1	97.3	2.8	0.938
After PDT	98.0	2.2	97.9	2.9	0.760
p	0.181		0.009		
PaCO2					
Before PDT	43.7	8.4	43.0	11.2	0.283
After PDT	44.6	8.9	41.8	7.9	0.321
p	0.348		0.482		
PaO2					
Before PDT	111.4	40.06	121.7	45.8	0.363
After PDT	121.2	35.0	135.9	49.9	0.191
p	0.160		0.031		
H2CO3					
Before PDT	30.1	6.5	28.7	5.1	0.367
After PDT	29.8	5.9	28.2	4.2	0.230
p	0.779		0.452		
pH					
Before PDT	7.4	0.1	7.4	0.1	0.903
After PDT	7.4	0.1	7.4	0.1	0.674
p	0.568		0.746		

PDT: Percutaneous dilatational tracheostomy
Independent samples t test

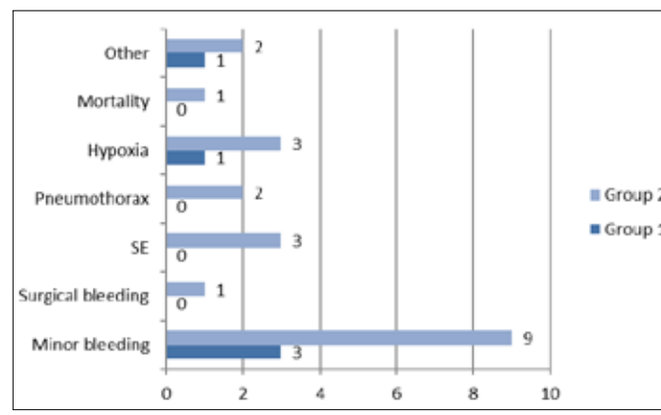

Figure 1. Distribution of the complications according to the groups.
SE: subcutaneous emphysema

The most common complication was minor bleeding in both groups, and it was observed in 10% of the patients in Group 1 and 30% of the patients in Group 2. No statistically notable difference was found between the groups in terms of complications (for all p>0.05). The distribution of complications according to the groups is shown in Figure 1. The mean duration of admission in the ICU was 28.8±20.2 days in Group 1 and 21.8±18.6 days in Group 2, and the difference was not statistically notable (p=0.088).

Discussion

Today, percutaneous dilatational tracheostomy (PDT) is increasingly used as an alternative to surgical tracheostomy. Fiberoptic bronchoscopy (FB) is the most commonly used technique for PDT [8]. In this study, we compared PDT applications with and without FB in terms of operational time, blood gas values and perioperative complications. In our study, no statistically notable difference was found between the two groups in terms of demographic and clinical data such as age, gender, BMI and GCS. Similarly, no significant difference was found between the FB and non-FB groups in the studies by Gadkaree et al. [9] and Maldonado et al. [10]. Again, in a study by Saritas et al., comparing FB and ultrasound guidance for PDT, no significant difference was reported in terms of the demographic data [6]. In this context, our findings are similar to those reported in the literature.

The duration of PDT operation is a major source of concern in critically ill patients. The addition of bronchoscopy to the procedure increases the cost [11]. The mean operational time was reported as 9.8±1.2 minutes by Shen et al. [12], 12.1±5.6 minutes by Tahal et al. [13] and 16.3±1.6 minutes by Ravi et al. [14] using flexible fiberoptic bronchoscopy. In our study, the mean procedure time was significantly longer with FB (13.4±4.9 minutes) compared to PDT without FB (8.1±6.1 minutes). Although the mean duration of operation with FB in our study was longer compared to non-FB procedures, it is consistent with the previously reported time range. We think that differences in the mentioned studies may result from the experience of the practitioners and the equipment used (e.g. flexible vs rigid bronchoscope etc.).

Bronchoscopy provides direct visualization, enabling education of those gaining experience in the insertion of tracheostomy. However, complication rates with bronchoscopy may also depend on the experience of the physicians [15]. In our study, the procedures were performed by experienced specialists or assistant doctors under the supervision of experienced specialists. Most of the cases, namely 25 cases (83.3%) in Group 1 and 24 cases (80%) in Group 2 were performed by the assistant doctors. Five (16.7%) procedures in Group 1 and 6 (20%) in Group 2 were carried out by experienced specialists. There was no notable difference between these two groups of physicians in terms of the parameters that we have studied.

Hypoxemia during bronchoscopy is caused by various factors. The bronchoscope itself decreases the airway's cross-section and restricts airflow [16]. Whereas, in our study, no notable difference was found between the FB and non-FB groups in terms of oxygen saturation. Moreover, no major difference existed before and after the procedure in our bronchoscopy group in terms of oxygen saturation. However, the increase in O2 saturation after the procedure was significant in the non-FB group (p=0.009). In a study by Hassanin et al., although O2 saturation decreased after sedation and during the procedure, there was no significant difference between the FB and surgical tracheostomy groups (p>0.05) [17].

Studies in the literature have reported concerns about unwanted side effects with bronchoscopy due to increased partial CO2 and partial O2 [18]. In the study by Hassanin et al., no notable difference was found between both groups in terms of PaCO2, while the increase in PaCO2 during tracheostomy in the FB group was significant [17]. In our study, no important difference was found between both groups in terms of PaCO2 both before and after the procedure. In addition, among other blood gas values, there was no significant difference between the groups in terms of PaO2 and pH values, both before and after the procedures (p>0.05). On the other hand, in a randomized controlled study by Eminoglu et al. comparing tracheostomy with FB and classical methods, there was a significant difference between PaO2 and pH values between 30 minutes before and 30 minutes after the operations, while pH values were noticeably lower in FB group following the procedure (p=0.01) [19]. We believe the differences between the studies might be attributed to several factors such as the techniques and equipment used and experience of the practitioners.

In general, complications caused by PDT procedures vary in a wide range from minor tissue damage to airway loss. Common complications include dysphonia, minor bleeding, surgical bleeding, posterior tracheal wall perforation, laryngotracheal stenosis and pneumothorax. In a study by Yaghoubi et al. on tracheostomy with fiberoptic bronchoscopy in 70 patients, subcutaneous emphysema, misplacement of the tube and mild hypoxia were seen only in one (1.4%) patient [7]. In the study by Gadkaree et al. comparing PDT operations with and without FB in 149 patients, no significant difference was found between the groups in terms of complications, and the authors concluded that the use of bronchoscopy would be beneficial [9]. Some studies have reported that although complications rates may be similar between tracheostomy procedures with and without FB, the risk of more serious and life-threatening complications may be higher when bronchoscopy is not used [11]. However, this was not confirmed in our study. In the present study, we most commonly encountered minor bleeding followed by hypoxia, subcutaneous emphysema, surgical bleeding and pneumothorax, although no notable difference was found between the groups in terms of the complications. Furthermore, the rate of minor complications was lower in the FB group compared to the non-FB group. We attributed this to the fact that the procedures performed by the inexperienced physicians were carried out under the supervision of the experienced specialists. In addition, major complications such as incorrect extubation, cuff rupture, esophageal perforation, tracheal stenosis, vocal cord paralysis and posterior wall damage were not observed in our study.

Study Limitations

The relatively small number of patients and the fact that the study was conducted in a single center are the main limitations of this study. In addition, late complications could not be

evaluated. Finally, it was not possible to analyze the length of hospital stay and total costs of both techniques. On the other hand, the prospective and randomized controlled nature of the study is its main strength.

Conclusion

The most important result of this study is that the procedure time is longer when fiberoptic bronchoscopy is used. However, blood gas values and complications were similar between the groups. Therefore, we believe that FB can be used as a safe and effective alternative to classical surgical tracheostomy under elective conditions based on experience of the physician, patient's preference and availability of technical equipment.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

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